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AUTHOR Iams, Jay D.
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ABSTRACT

Some of the principal research advances of the 1970s related to pregnancy and newborn infants and consequent changes in obstetrical practice are summarized in this report. The process of infant-parent attachment (bonding), adolescent pregnancy, and the reproductive hazards of tobacco, alcohol, and poor nutrition have been investigated and, in several problem areas, new risk-reducing medical practices have been developed and implemented. Still, prematurely born and low birthweight infants comprise a disproportionate share of perinatal morbidity and mortality. Prevention of such births continues to be a research priority in the 1980s. Additionally, birth problems associated with the Rh factor of red blood cells of mothers and their infants have not been eradicated. Ultrasound, a diagnostic technique that uses the reflected echoes of high frequency sound waves to see inside the human body, has been used in intrauterine transfusion of red blood cells, thus avoiding fetal irradiation. Other technological advances include the monitoring of fetal health during labor via electronic fetal heart rate monitoring and fetal blood tests. To provide all necessary maternal and neonatal care in the most cost-effective manner, a system of regionalized graded levels of perinatal services has been successfully established. Newborn transport and continuing education programs have been critical to the success of these services. (Author/RH)

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MATRIX NO. 6

BEING WELL BORN:

PREVENTIVE HEALTH PRACTICES

IN PREGNANCY AND DELIVERY

by

Jay D. Iams, M.D.

College of Medicine
The Ohio State University

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BEING WELL BORN:
PREVENTIVE HEALTH PRACTICES IN PREGNANCY AND DELIVERY

The decade of the 1970s witnessed an explosion of medical knowledge relating to pregnancy and newborn infants. New techniques to evaluate the health of the unborn infant were introduced. As the physiology of labor became better understood, new approaches to halt premature labor were developed. Our approach to care of the woman and fetus in labor has undergone reevaluation, and continues to evolve with the concept of risk assessment. Neonatal intensive care units have produced an improved rate and quality of survival for very low birthweight infants, even those less than 2 pounds. This has, in turn, prompted changes in obstetrical practice that would have been thought preposterous only a decade ago. Certainly these changes in the way we care for our most important resource have not always been free of controversy. False starts have been made; great expectations have been created and later revised by the wisdom of experience. The research of the '50s and '60s, which provided the scientific basis for the new techniques of the '70s, has now, in turn, fostered grandchildren. What we have learned in the '70s, both at the research bench and at the bedside, has prompted a whole array of questions to be answered by the research of the 1980s. This section describes several of the major developments in reproductive biology and medicine during the 1970s, and outlines some of the research horizons for the 1980s and beyond. Research in the area of pregnancy is surely deserving of continued and increased support, since so many of the problems of children and youth discussed in other papers in this Forum have their origin in prenatal life.

Family Centered Care and Parental-Infant Attachment

Animal research in the last two decades revealed a definite series of steps in the normal development of the parent-infant relationship. Failure to complete this process was associated in these studies with subsequent abnormal parent-offspring relationships, including rejection of the infant by the parent. Research, in part supported by NIH funds, has tested applicability of these observations to human reproduction and found marked similarity. Klaus and Kennell and others have shown that attachment of the parents, especially the mother, to the infant begins long before birth, and is enhanced by the various milestones of pregnancy and again by the birth experience. Following delivery, mothers normally become acquainted and attached to the newborn through a series of steps called "bonding." There are, of course, many individual and cultural variations, but the basic steps remain similar. Abnormalities of the maternal-fetal and maternal-infant attachment may develop for several reasons; these have been correlated with suboptimal pregnancy outcome and subsequent parenting difficulties.

This research has prompted several changes in the American approach to childbirth. Unplanned pregnancies now are targeted for special effort to help foster maternal-fetal attachment in early pregnancy. Routine hospital practices, such as immediately removing the newborn to the nursery, have been revised to encourage close parent-infant contact in the recovery room. Family centered childbirth education programs received a new impetus for expansion as a result of this research. Labor practices

have changed: certain drugs in labor are avoided now, because of suspected adverse effects upon maternal or infant bonding behavior after delivery; fathers now often accompany the mother to surgery for cesarean birth; and the use of conduction anesthesia, rather than general, for cesarean section is increasing, because it allows the mother to remain awake and see her infant immediately. Sometimes normal bonding practices are not possible because the infant is born prematurely and must be cared for in an intensive care unit. Bonding research has prompted NICUs to encourage early parental contact with even the tiniest newborn. The same steps are followed, but over a longer time period. Infants with malformations and infants who die in the perinatal period present special emotional problems for the parents, and research has again altered the approach to assisting parents in these difficult situations. There is more to be learned about the effectiveness of intervention strategies in promoting a healthy parent-child relationship. The effects of this work can have obviously far reaching import for our whole society.

Adolescent Pregnancy

Research of the 1960s led to a growing awareness of adolescent pregnancy as a major social and health care problem. Pregnancy in adolescence often produces less than optimal outcomes for both the mother and the infant. From a health perspective alone, the outcome of pregnancy for girls less than 15 years of age is discouraging: a higher maternal mortality rate, an increased rate of hypertensive disorders, a twofold increase in the incidence of low birthweight infants, and a 25% increase in perinatal mortality. The social and educational consequences are perhaps more insidious, but nonetheless destructive: 80% of women who deliver before their 18th birthday do not finish high school, and 40% of girls who deliver before age 15 do not finish the 8th grade. Fully one-third of pregnant teens will become pregnant again within 18 to 30 months after their first delivery.

During the decade of the '70s, adolescent pregnancy programs were developed in a number of centers in the United States. They began with the knowledge that the outcomes were poor; the reasons for this poor outcome were less evident. Is there something biologically different about the teenager that predisposes her to the medical problems cited above? Or, are the adverse consequences of adolescent pregnancy social in origin – poor nutrition, poor or no prenatal care, poor family support, etc.? The adolescent pregnancy programs developed over the last 10 years have analyzed their work and have provided some answers to these questions. Above age 15, there is nothing high risk about adolescent pregnancy that good and early prenatal care cannot prevent. The social risks are the principal determinants of poor outcome in this group. Below age 15, there may be inherent biologic risk related to age and the competing nutritional and endocrine demands of pregnancy and adolescence. The answers are not all in yet, but we have learned two principal lessons in the last 10 years: prevention of adolescent pregnancy is surely the ideal; when a teen does become pregnant, the best outcome derives from early and regular prenatal care.

Environmental Influences on Pregnancy

The thalidomide disaster of the early '60s created wide public awareness of the adverse effects of drugs in pregnancy. Investigation of the perinatal effects of medication continues to be a research priority. These investigations have been broadened to include environmental agents, because of increased public concern about such hazards. Cigarette smoking, alcohol, nutritional influences, and over-the-counter medications have been subjected to increased scrutiny. Chapter 3 of the 1979 Surgeon General's Report on Smoking and Health summarizes current information about the impact of smoking on reproductive outcome. Smokers have increased rates of low birthweight babies (< 2000 grams) and lower birthweight infants throughout all infant weight categories. Smokers have an increased rate of spontaneous abortion, and of fetal and neonatal death. The mechanisms responsible for these effects are not yet entirely clear. Indeed, the Surgeon General's Report lists 88 research goals about smoking and pregnancy that remain unfulfilled at present.

The adverse effects of maternal alcohol consumption have been suspected since Biblical times (see Judges 13:7), but only in the last decade has the full reproductive impact of this substance been realized. Central nervous system dysfunction, retarded antenatal and postnatal growth, and unique facial features comprise the Fetal Alcohol Syndrome. Clearly, alcohol is one of the few substances to achieve *proven* status as a teratogen agent. It is also the most widely used and abused teratogen known. Many questions remain for researchers of the next decade: What are the mechanisms of alcohol teratogenicity? How much alcohol intake is necessary to produce an effect? Is there a *safe* dose? Can alcohol embryopathy be diagnosed and treated before birth? These are problems that affect many more Americans than most would care to admit, and they will not go away.

Perhaps the greatest controversy and confusion surround the question of nutrition in pregnancy. The public and the research community are agreed that good nutrition is essential to a healthy pregnancy, and that many of the complications of pregnancy are associated with poor nutrition. Causal relationships between malnourishment and toxemia, premature labor, prematurely ruptured membranes and other disorders have all been proposed but not confirmed. Intervention strategies, such as nutritional supplementation and education programs for pregnant women, are endorsed widely but are still lacking a firm support base in research. Common sense and clinical experience tell us that good nutrition is good for pregnancy. If we only understood more about why that is so, we might be able to understand, and, therefore, prevent many of the common complications of pregnancy.

Other questions about the reproductive impact of our environment remain just that: QUESTIONS. What are the reproductive hazards of the workplace? The influx of women of reproductive age into the work force has made this a high priority item. As our country develops energy resources for the future, questions about the reproductive effects of each potential energy source will need to be answered. Public concern now far exceeds research support in this area.

Premature Birth

The prevention of premature birth surely must rank as one of this country's highest health priorities. Approximately 8% of births in the United States occur before the fetus has had a chance to develop fully. These 8% of infants, born too soon, account for 70% of all perinatal morbidity and mortality. The incidence of perinatal and neonatal death, cerebral palsy, and mental retardation all increase dramatically with decreasing gestational age at birth. The reasons for being *born too soon* fall into three large categories:

1. Maternal medical or obstetrical illnesses in which preterm delivery is safer than continuation of the pregnancy. This includes such illnesses as toxemia of pregnancy, diabetes mellitus, and maternal Rh isoimmunization. Avoidance of premature birth in these instances depends upon medical/obstetrical prevention and/or care of the underlying illness (see Sections on Rh Isoimmunization and on Diabetic Pregnancy).
2. Premature rupture of the amniotic sac. Spontaneous labor often follows rupture of the fetal membranes. When this occurs prior to full fetal development, an immature infant is often the result. The cause of spontaneous membrane rupture prior to labor is unknown and remains a fertile area for research. Prevention is clearly the key but is impossible unless the reasons are understood. Research support of this area has been scant.
3. The spontaneous onset of labor prior to 37 weeks of gestation in the absence of medical illness or ruptured membranes remains an enigma. It is embarrassing to admit that in 1981 we do not yet fully understand the impetus for normal labor at term. Until research unlocks this mystery, our approach to prevention and treatment of premature labor will remain less than satisfactory. The 1970s has been an active decade for research in this area. A cascade of maternal and fetal biochemical events leading to labor has been identified. Substances called prostaglandins appear to play an integral role in the labor process. Drugs designed to inhibit prostaglandins may have promise in stopping or preventing premature labor. The physiology of uterine muscle has been explored, and has led to the FDA approval in 1980 of a new drug, ritodrine, to stop premature labor. It is more effective and has fewer side effects than previous agents.

The research of the 1970s now has built a strong foundation for further research aimed at prevention of premature birth. The benefits to future generations are beyond estimation.

Rh Isoimmunization

Fifteen percent of women lack the rhesus or Rh factor in their red blood cells, and are therefore called "Rh negative." An Rh negative individual exposed to Rh positive red blood cells will produce antibody to the Rh factor, and become permanently *sensitized* or isoimmunized. Such exposure may occur when an Rh negative woman carries and delivers an Rh positive infant. Rh positive fetuses carried in subsequent pregnancies by sensitized mothers then are exposed to maternal antibody that destroys developing red blood cells. The result may be premature delivery,

brain damage, and, in some cases, death. In 1968, Rho(D) Immune globulin (Rhogam), designed to avert maternal sensitization, was introduced into obstetrical practice after years of animal and human research.

It was hoped that the problem of maternal sensitization then would become an historical curiosity, but that has not happened. Maternal Rh isoimmunization has declined dramatically but has not disappeared. Clinical evaluation of Rhogam during the 1970s has identified several remaining sources of maternal sensitization to the Rh factor: (1) Unrecognized early pregnancy loss may result in sufficient maternal exposure to fetal Rh positive cells to produce anti-Rh antibodies in the mother, (2) Spontaneous leakage of fetal cells into the maternal circulation may occur during gestation in as many as 1% to 2% of pregnancies, and (3) Rhogam in the usual dose of 300 micrograms postpartum is not 100% effective in preventing maternal sensitization. Control of the Rh problem will require cost-effective responses to each of these situations; there is not as yet universal agreement on appropriate strategies. In some Rh sensitized pregnancies, the destruction of fetal red blood cells is so overwhelming that death of the fetus may be expected unless an intrauterine transfusion of red cells is given to the fetus. Ultrasound, described in the next section, has replaced x-ray techniques in the performance of this difficult and risky procedure, thus avoiding fetal irradiation. Less invasive, and, therefore, less hazardous means of treating these fetuses are yet to be developed.

Ultrasonography

Ultrasound is a diagnostic technique that uses the reflected echoes of high frequency sound waves to *see* inside the human body. The basic principles of using sound wave echoes have their origins in military experience with radar or sonar. Research in the last 10 to 20 years has refined this technology for medical use. Ultrasound has proven useful in many areas of medicine, but especially so in obstetrics. The developing embryo and fetus now can be observed throughout pregnancy. As a result of this research, we now are able to evaluate the fetal condition before birth in ways never before possible. Previous techniques, such as clinical examination and x-ray studies, provided far less information, sometimes with more risk than benefit. The duration of pregnancy is the benchmark against which all prenatal measurements are compared. Ultrasonographic measurement of fetal crown-rump length, head size and abdominal circumference yields a reliable estimate of the duration of gestation. Once gestational age is determined, serial ultrasound examinations can detect excessive or deficient fetal growth as may occur in diabetes, hypertension and other medical disorders complicating pregnancy. The early diagnosis of twin pregnancies via ultrasound promotes efforts at minimizing the complications of multiple pregnancy. Ultrasonographic evaluation of women with bleeding in pregnancy can reveal abnormalities in placental location or attachment, and assess viability of the embryo in cases of threatened miscarriage.

As discussed in the section on Antenatal Diagnosis of Congenital Disorders, ultrasound now plays an important role in the prenatal diagnosis of congenital diseases and defects. Sampling the amniotic fluid via amniocentesis appears to be safer if the fetus and placenta are first located precisely with ultrasound.

Ultrasound has enabled researchers to ask new questions about normal and abnormal fetal development. The next decade should be one of exciting discovery in this area. Thus far, no risks of pulse-echo sonography in the human have been confirmed, but this must remain a continuing research priority. The development and application of high energy sound wave echoes in medicine are two of the principal research accomplishments of the last decade, and promise even more advances in the next.

Evaluation of the Fetus in Labor

The Collaborative Perinatal Project of the 1950s and 1960s produced data that revealed the inadequacy of intermittent auscultation of the fetal heart rate in assessing the fetal condition in labor. During this same time, researchers in several countries demonstrated a correlation of continuously recorded fetal heart rate patterns with fetal condition. These two research programs led to the introduction of electronic fetal monitoring (EFM) into routine obstetrical practice in the 1970s. The accumulated research of the '70s, about how well EFM has worked to minimize the fetal risks of childbirth, was recently summarized by an NICHD Consensus Development Task Force. The Task Force concluded that, at present, continuous EFM offers little, if any, safety advantage to normal laboring women, but appears to have increasing benefit to the fetus whenever risk conditions, such as low birthweight infant, abnormal labor, or medical or obstetrical illness, are present. It is also of value whenever oxytocin is necessary. EFM has definite limitations and occasionally some risks, identified by research. The effect of EFM upon the incidence of cesarean section is still uncertain, and requires more study. Current research is aimed at finding the most appropriate use of this technique. Are there means of selecting laboring women who will or won't benefit from continuous EFM? Should all women have intermittent EFM, e.g., for 30 minutes of each 2 or 3 hours of labor? Does ambulation with radiotelemetry of EFM data improve the quality and outcome of labor? Does measurement of other fetal cardiac or neurologic data help in diagnosis of fetal distress? The goal of providing a safe and effective screening technique for fetal distress in labor has not yet been reached. The research of the next decade may move us closer to that goal.

Antenatal Diagnosis of Congenital Disorders

Antenatal detection of congenital defects and disorders has become an established part of prenatal care. Ten years ago, the necessary technology was just beginning to move from the research laboratory into hospitals, offices and clinics. We have learned that there are three basic components of antenatal diagnosis: screening, counselling and diagnosis. The most important and most difficult is screening: identification of individuals of increased risk of a congenital disease or defect. The second is counselling: explaining the potential benefits, limitations and risks of various diagnostic procedures to individuals at risk. The last component is comprised of the diagnostic procedures available, including testing of blood and amniotic fluid, and ultrasound. Great progress has been made in each of these areas in the last decade, but antenatal diagnosis is still in its infancy. Advancements in developing various new diagnostic procedures has preceded the first two, more fundamental, areas. A large NICHD coordinated and funded study has demonstrated the safety

and accuracy of second trimester amniocentesis in detecting fetuses with chromosomal anomalies. Ultrasound has improved further the safety and accuracy of amniocentesis to obtain fluid for study. Techniques of chromosome analysis and tissue culture have improved our ability to diagnose chromosomal aberrations such as Down's Syndrome. Alpha-fetoprotein testing of maternal blood and amniotic fluid can identify a fetus with open spina bifida, a serious congenital defect of the brain or spinal column. Ultrasound evaluation of the fetus can also detect some cases of spina bifida, as well as congenital disorders of the kidney, gastrointestinal tract, and limbs. Biochemical tests of amniotic fluid, or of cultured fetal cells obtained by amniocentesis, can test for more than 100 inherited disorders, and this number continues to grow. Cystic fibrosis, the most common genetic disease in white Americans, is not yet among those disorders, but research is ongoing. Problems remain in finding simple and cost-effective methods of screening large numbers of people who might benefit from antenatal diagnostic techniques. Educational programs for both consumers and providers of these health services need to be developed, for there are many misconceptions and unrealistic expectations in this area. The advances made in the 1970s provide a firm basis for the difficult problems that remain.

Antepartum Assessment of Fetal Well-Being

Pregnant women seek prenatal care for one simple reason: To safeguard their own health and the health of the baby during pregnancy. Research of past decades has shown that this reasoning is sound; women who receive early and regular prenatal care do have healtheir pregnancies with better outcomes. Physicians and nurses, who provide prenatal care, are charged with the responsibility of screening a large population of predominantly healthy women to identify those at risk of suboptimal outcome. Techniques in current use include historical assessment, and serial evaluation of uterine growth, blood pressure, maternal nutrition, weight gain, and urine. These methods remain the cornerstones of good prenatal care, but are not always successful in avoiding the complications of pregnancy. In the past 10 years, additional methods of pregnancy assessment have been introduced. Pregnancies identified as high risk now are followed with serial measurement of blood or urinary estriol, and with periodic fetal heart rate testing (called "nonstress" or "stress testing," depending upon whether the fetal heart rate response to the stress of uterine contractions is utilized). Such testing may indicate fetal jeopardy and prompt early delivery to avert stillbirth. Conversely, reassuring estriol and heart rate determinations can allow continuation of high risk pregnancy until near term. The principal hazards of preterm birth is neonatal respiratory distress syndrome (RDS), or hyaline membrane disease. Amniotic fluid can be analyzed in complicated pregnancy for the presence of surfactant compounds. If these surface active compounds are present in amniotic fluid, preterm delivery, in the face of obstetrical complications, can be accomplished without undue fear of neonatal RDS. These tests are not by any means perfect, and are modified by numerous conditions and variables. Further, they are applied only to a select group of women, who already have pregnancy-related complications. What about screening techniques applied earlier in pregnancy, perhaps in time to prevent more serious complications? Measurement of the mean arterial blood pressure in mid-pregnancy and the *rollover* blood pressure test have

been proposed to identify women at risk for later development of pre-eclampsia. Both appear to have merit, but require more study. There is no screening test for those women who will have ruptured membranes prior to term, nor for those who will labor too soon. Maternal recording of daily fetal movement activity is an old idea, reintroduced to our technologically oriented era, which may have promise as a universal screening test. Problems of cost-effectiveness, specificity, and sensitivity exist for all such prenatal testing. The American public should not be satisfied until each pregnancy attains its optimal conclusion, and, therefore, the effort in this area should certainly continue.

Diabetic Pregnancy

Pregnancy complicated by maternal diabetes affects a relatively small number of women, but is included here, because it illustrates well the human benefits of basic and applied research. Prior to the discovery of insulin, the mere existence of a pregnant diabetic was rare. When pregnancy did occur in a diabetic, the outcome was often miscarriage, or stillbirth, and maternal death. Insulin therapy led to improved maternal fertility and a decrease in the maternal risks of pregnancy, but the fetal mortality was still high. Intrauterine fetal death in late pregnancy was common, especially in women whose diabetes was severe and/or longstanding. This fear of stillbirth prompted a program of early delivery; the more severe the diabetes, the earlier delivery was recommended. Neonatal morbidity and mortality then increased as the incidence of stillbirth declined only slightly. The 1970s saw two changes in obstetrical practice that have greatly improved the outlook for diabetic pregnancies. The first was the intensive fetal evaluation testing described in the previous section. The second was the report, in 1972, by Swedish researchers of improved pregnancy outcomes for diabetic women whose blood sugars were controlled very tightly during pregnancy. American investigators quickly adopted the Swedish approach and reported similar results. Costs increased greatly, however, since *tight control* often meant prolonged hospitalization in the last trimester of pregnancy. Simple self-blood sugar measurement devices for use at home have been introduced recently. These products of private industry research have led to a decline in costs of laboratory testing and hospitalization, while maintaining the goal of careful control of maternal blood sugar. In 1980, the diabetic woman can look forward to pregnancy, knowing that her chances of successful childbearing approach those of the nondiabetic. Diabetic progeny however are two to three times more likely to be born with congenital anomalies than infants of nondiabetic women. The reasons for this are not known, but may be related to maternal blood sugar changes, or to underlying genetic differences between diabetic and nondiabetic parents. Basic research into the several causes of diabetes perhaps will shed light on the latter possibility.

Infections in Pregnancy

So much has been learned in the last century, and especially in the last 40 years, about infectious diseases, that we often forget how much there is still to learn. We need only look at the causes of morbidity and mortality among pregnant women and their infants to realize that infectious agents of all kinds still afflict mankind.

Two long-known and well-studied organisms, the Group B streptococcus and Escherichia coli, were the most common causes of serious newborn infection during the 1970s, yet, antibiotics able to kill both organisms may be found in any pharmacy. Gonorrhea, with its terrible toll of sterility, has increased rather than declined in incidence in the last 10 years. Why are we still plagued with these diseases? There is still much to learn about the relationship between bacteria and mankind, their hosts. Bacteria are not so foolish as one might expect – they too wish to survive, and often adapt to our drugs as fast as we can create them. Continued research support is required, if only to remain one step ahead.

Viral infections are even more difficult, not easily treated but only controlled. The 1970s saw the beginnings of a success story in this field with the introduction of a safe and effective immunization against rubella virus, the cause of German measles. In 1962, researchers were able to grow the rubella virus in the laboratory. Rubella vaccines were introduced in 1968, too late to prevent the destructive effects of the 1964 rubella epidemic upon developing fetuses. Since its introduction, the rubella vaccine has undergone continued evaluation and refinement based on epidemiologic and basic research. Questions of vaccine effect upon the unborn fetus, and duration of protective effect remain to be answered.

Other viruses continue to exert a major adverse effect on the children of this country. Cytomegalovirus in pregnancy produces neurologic deficits in approximately 4000 infants per year in this country. Maternal infection is often silent. Researchers have not yet produced a vaccine against this most common viral pathogen. Herpes simplex virus (HSV) when present in the birth canal during labor may infect the newborn infant with disastrous consequences: approximately one-third of these infants die, and another one-third suffer severe handicap. HSV is a venereal disease, which produces frequent recurrences; there is no cure. The need for further study of means of prevention and treatment is clear. Infections, both viral and bacterial, often are found in association with preterm and/or low birthweight infants. Viral infections, such as cytomegalovirus in early pregnancy, are known to retard fetal growth. Suspicion of a causative role for bacterial infection in the etiology of premature labor and prematurely ruptured membranes is strong but remains unconfirmed. Researchers already have taken aim at eliminating these important causes of suboptimal pregnancy outcomes.

Regionalization of Perinatal Services

The knowledge explosion in perinatal biology in the 1970s started in the laboratories of the 1960s, and grew to maturity in the regional perinatal centers of the 1970s. The changes in reproductive medicine described in this section did not occur without cost: cost of equipment, hospital space, and highly trained personnel. In order to offer the best perinatal care to every citizen, without costly duplication, the concept of regionalized perinatal services was developed. Federal and private sources provided the funding for pilot programs in Wisconsin, Arizona and Ohio. Significant improvements in perinatal mortality were recorded in these states with the establishment of newborn intensive care units that provided regional or statewide service. Newborn transport and continuing education programs were critical to this success.

Recently, regional maternal transport, consultation, and educational networks have shown further improvements in perinatal morbidity and mortality. The continuing education function of the tertiary regional centers should not be underestimated. Outreach programs, which bring the latest research advances to smaller communities, should provide the ounce of prevention that avoids the pound-cure of high level technology offered only at the regional center. This regionalized system is not yet fully developed; the best manner and mode of regionalization remains controversial. Research on such a broad level is always expensive, but certainly is less costly than suboptimal health care for America's greatest resource: her future citizens.

Summary

There have been profound changes in both routine and specialized obstetrical care practices in the last decade. These changes affecting perinatal care are, in each case, the product of research efforts that required considerable expenditures of time and money. The ultimate goal of research in this area is the best possible beginning for our newest citizens. This report summarizes some of the principal research advances of the 1970s, and the consequent changes in obstetrical practice.

The process of infant-parent attachment, or bonding, has been studied extensively. The effects of this new knowledge can be seen in hospitals and birthing centers across the country, in expanded family-centered childbirth programs, encouragement of maternal-infant bonding practices, and even in neonatal intensive care units. Adolescent pregnancy often was associated, 10 years ago, with poor outcome; this, in turn, led to the development of adolescent pregnancy programs. The research efforts of these programs now have identified specific reasons, principally social rather than medical, for such adverse outcomes. Early and regular prenatal care can convert these high risk teens to low risk status. Prevention is, of course, the most logical approach. Reproductive hazards of tobacco, alcohol and poor nutrition have been further investigated. Although much remains to be learned, these and other environmental factors have been shown to have a significant influence on the health of the fetus.

Prematurely born and low birthweight infants still comprise a disproportionate share of perinatal morbidity and mortality. Prevention of such births, therefore, continues to be a research priority. Our understanding of the mechanisms of normal and abnormal fetal growth, development and labor physiology have progressed greatly since 1970, but there is still a long way to go in this area. More than a decade has passed since the introduction of Rh immune globulin, yet rhesus isoimmunization remains a stubborn problem. The final solution depends again on the research of the 1980s.

Ultrasonography is surely the principal technological advance in perinatal medicine in the 1970s. This technique provides hitherto unobtainable information about the anatomy and physiology of pregnancy. Ultrasound provides the researchers of this decade with an immeasurably useful resource. Research also has altered many aspects of prenatal and intrapartum care. Prenatal diagnosis of more than 100 disorders is now possible, through a combination of screening programs, ultrasound, and amniocentesis. Pregnancies complicated by such diseases as diabetes or high

blood pressure now are followed very differently than was the case a decade ago, with demonstrable improvements in newborn survival. Evaluation of the health of the infant during labor via electronic fetal heart rate monitoring and fetal blood tests now is available to most labors in this country. Research continues into the most appropriate use of these and other methods of fetal evaluation. Our knowledge of the diagnosis and treatment and, more important, the prevention, of perinatal infections has grown considerably since 1970, but there remain many problems yet to be solved.

Many of the advances outlined above, of course, are expensive, and applicable only to selected pregnant women and their infants. A system of regionalized graded levels of perinatal services has been established to provide all necessary care in the most cost-effective manner. The initial results of this regionalized network of perinatal care are encouraging; further research is necessary to identify the most appropriate patterns of regionalized care and continuing education.

Many of the health problems of infants and children have their origin in prenatal life or arise during labor and delivery. In some instances, the relationship between a prenatal insult and a childhood handicap is clear, such as maternal rubella or CMV infection. In others, the cause and effect relation is strongly suspect but not yet fully understood; medications and environmental exposures are typical. In still others, such as intrapartum fetal asphyxia, the clear relationship between perinatal insult and childhood disability affects only a small number of births of the many at risk. The best screening methods are not yet clear. Research in all reproduction related areas, directed at both basic and clinical questions, clearly offers the most cost-effective use of limited research dollars in the 1980s.

The papers presented to this Forum on the health needs of infants and children, in almost every instance, include reference to the prenatal or perinatal genesis of the problem discussed. While the health needs of today's children cannot be ignored, perinatal research offers the hope of avoiding many health problems for the children of tomorrow.

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